Unit 1: Evolution

AP Biology

Mrs. Petrov

A. What is Evolution?

- A change in the genetic makeup of a **population** over time is evolution.

What is genetic makeup?

What is a population?

Are human populations today the same as ancient human populations? Explain.

B. What Leads to Evolution?

- Individuals vary genetically & DNA can mutate
- Results in varied phenotypes

What are some mechanisms that make individuals of the same species vary genetically?

How does DNA mutate?

Explain the varied phenotypes in the pumpkins above.

B. What Leads to Evolution?

- Environments change constantly
- Results in some individuals having **adaptations** that allow them to survive and reproduce more frequently than others
- **Evolutionary Fitness depends on the particular environment!**

In a population of finches, beaks can vary in width. Thinner beaks are less able to crack open hard seeds that are produced as a result of drought. If a drought were to occur, predict the likely effects on beak width in the next generation of finches and justify your prediction.

Bighorn Sheep

What adaptations do the sheep have that allow them to survive in their environment?

Plant Trichomes

What adaptations do the plants have that allow them to survive in their environment?

B. What Leads to Evolution?

- **Artificial Selection**: Humans artificially select for desired traits
- **Natural Selection**: Nature "selects" individuals best suited to their environment to survive and pass on their genes. This leads to a change in the gene pool over time.

What are some examples in society where humans have artificially selected organisms for their wants/needs?

"Natural Selection" is a term developed by Charles Darwin after he observed how humans artificially select organisms to continue breeding. Explain why "**selection**" by nature is actually very inaccurate compared to what really happens in natural selection.

B. What Leads to Evolution?

- **Natural Selection** is the *major* mechanism of evolution.
- Other mechanisms:
  - Genetic Drift
  - Non-Random Mating
  - Migrations
  - Mutations

Define the other mechanisms of evolution:

C. Modeling Evolution

- The Hardy-Weinberg Model
  - This is a NULL model: if assumptions are met, it models that NO evolution is occurring.
  - If a change from 1 generation to the next IS observed, this demonstrates that evolution IS occurring.

C1. H-W Assumptions

- No Natural Selection (not likely)
- No mutations (not likely)
- No migration (maybe)
- Random mating (not likely)
- Large population size (maybe)

All conditions seldom met!

Explain why each assumption is likely or not

C2. H-W Model

$p^2 + 2pq + q^2 = 1$ $\quad\quad$ $p + q = 1$

p^2= proportion of **homozygous dominant** individuals

2pq = proportion of **heterozygous** individuals

q^2 = proportion of **homozygous recessive** individuals

p = proportion of **dominant alleles**

q = proportion of **recessive alleles**

Traits are usually 1 of 2 variations (alleles) : Tall allele vs. short allele
If each parent donates a dominant allele, the offspring will be homozygous dominant.

In genetics, we use letters to describe traits. For example, round is dominant to square. Capital R is a round allele but lowercase r is a square allele.

Usually, what would the genotype and resulting phenotype be?
homozygous dominant _____ = _____
Homozygous recessive? _____ = _____
Heterozygous? _____ = _____

In the HW formulas, the dominant allele is P and the recessive allele is q (not lowercase p).
Re-write the genotypes and phenotypes using HW letters p & q
Homozygous dominant _____ = _____
homozygous recessive _____ = _____
Heterozygous _____ = _____

Also remember that these formulas look at the entire population, so that would be the sum of ALL the alleles present in each organism.

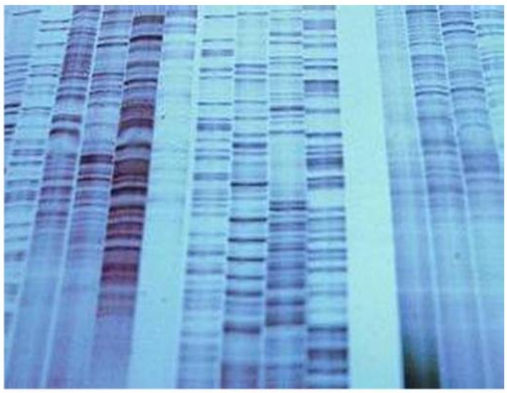
If a diploid population (2 copies of each allele per individual) has 20 members, how many alleles are in the population's gene pool?

Practice Problem

- In a population of 100 trees, 30 individuals are homozygous recessive for small trichomes.
- If the population is in HW equilibrium (no evolution occurring), how many dominant alleles should be in the population next generation?
- How many heterozygous individuals should there be?

D. Evidence for Evolution

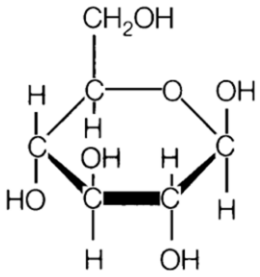
- Genetic data
  - DNA and Protein sequence similarities

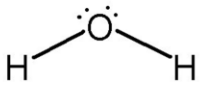


Most people would not think a human and mouse have much in common. Looking at genetic data, such as the underlying codes for proteins can reveal our evolutionary relationships!

D. Evidence for Evolution

- Bimolecular data
  - Similar compounds conserved
    - Glucose: Energy source of life
    - Water: Solvent of life

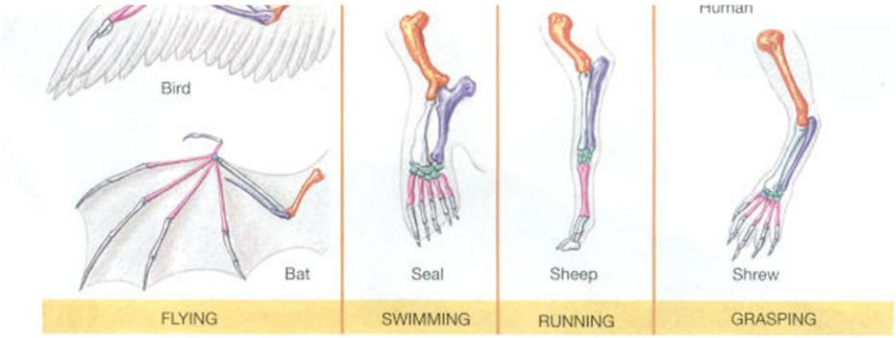




Some interesting questions…
Can molecules undergo natural selection?
Ex. Why is water so widely seen in organisms versus a liquid such as ethanol?
Ex. Why is glucose used as a primary energy source in all life?

D. Evidence for Evolution

- Morphological data
  - Homologous structures
  - Embryo similarities



Define homologous structures

How do they reflect evolution from a common ancestor?

D. Evidence for Evolution

- Fossil dating
  - Age of rock
  - Isotope decay (Carbon-14)

Each layer of rock (strata) reveals conditions of the Earth at specific periods of time. Fossils found there can be analyzed to show relationships to its ancestors and descendents.

D. Evidence for Evolution

- Disciplines other than biology provide evidence
  - Geography
  - Geology
  - Chemistry
- Mathematical models assist also
  - HW model
  - Molecular sequence databases
  - Phylogenetic analysis

Give an example of how each discipline can provide evidence in evolution studies.

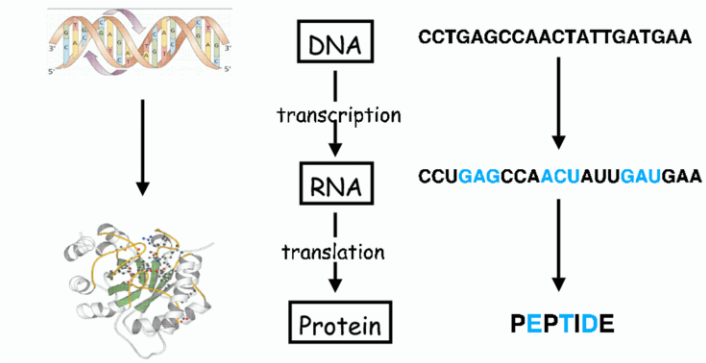
- A Tyrannosaurus Rex femur was found in southern Africa within a rock formation and a second unidentified dinosaur bone was found in the same rock formation, about 4 meters away. Describe how you could figure out if the 2 bones were from the T-Rex or if the second bone was completely different. Justify your answer!

E. Conserved Features

- DNA & RNA carry out genetic processes

  Transcription Translation Replication

- The Genetic Code



Define Transcription & Translation

How is transcription different from replication?

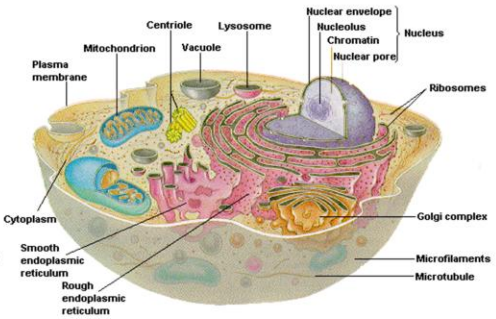
Explain how genetic diversity can result in each process.

E. Conserved Features

- Metabolic Processes
  - Glycolysis in ALL organisms
    - Metabolize glucose for energy
  - Photosynthesis (Plants, algae, cyanobacteria)
    - Create carbon compounds from CO_2 & Water

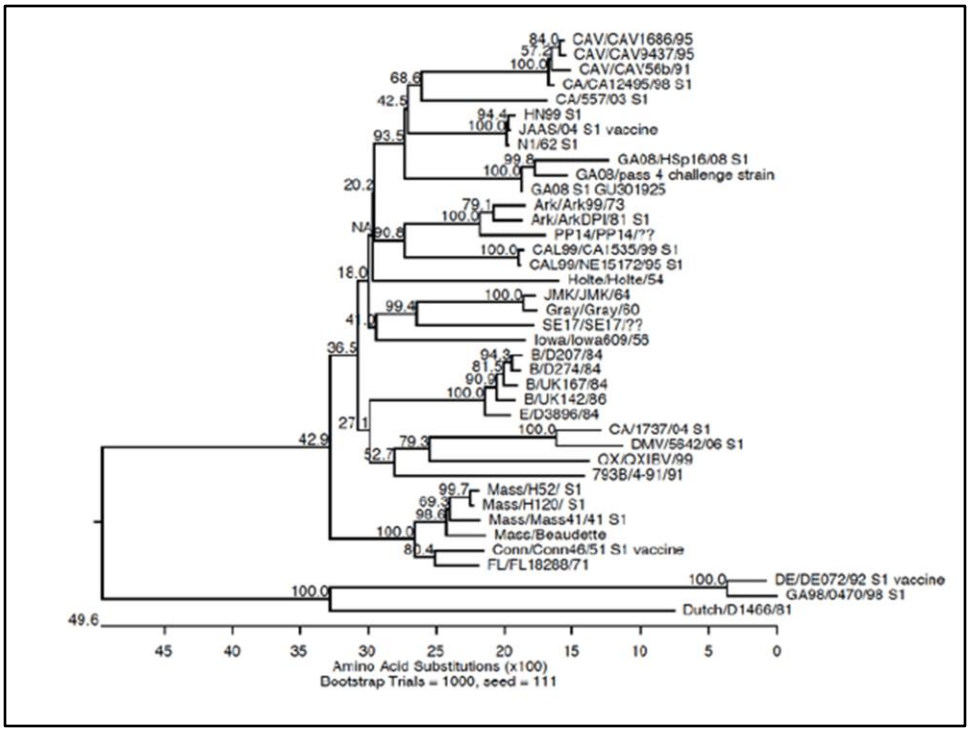
E. Conserved Features

- Eukaryotes
  - Cytoskeleton (structural proteins)
  - Membrane-Bound Organelles
  - Linear Chromosomes
  - Endomembrane transit systems



F. Modeling Ancestry: Phylogenies

- Phylogeny: An organism's evolutionary history
- Illustrate
  - relatedness to others
  - Speciation timing
- Data from
  - Morphology
  - Genetic data
- Computers for complex modeling
- Constantly being revised based on new data!



What does each “Branching” event indicate happened?

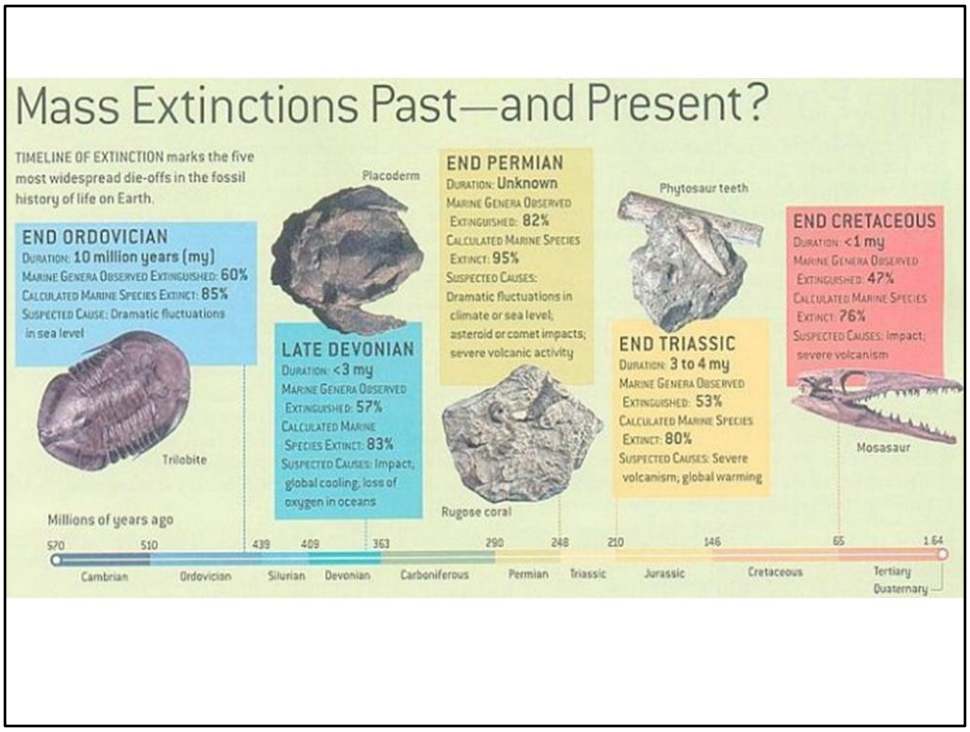
G. Speciation

- Result of reproductive isolation from
  - Geologic events: Floods, volcanic eruptions
  - Reproductive barriers
    - Pre-zygotic: reproductive structure incompatibility
    - Post-zygotic: Hybrid sterility/mortality
  - Mutations: Polyploidy in plants
- Leads to a diversity of life forms

Lions and Tigers and Ligers, Oh my!

G. Speciation

- Rates of speciation vary widely
  - Habitat availability, competition, geologic events
- Extinction can be rapid if ecosystem is stressed
  - Dinosaurs
  - Human impacts on Tropical Rainforests


Mass Extinctions Past—and Present?
TIMELINE OF EXTINCTION marks the five most widespread die-offs in the fossil history of life on Earth.
END ORDOVICIAN
DURATION: 10 million years (my)
MARINE GENERA OBSERVED EXTINGUISHED: 60%
CALCULATED MARINE SPECIES EXTINCT: 85%
SUSPECTED CAUSE: Dramatic fluctuations in sea level
Trilobite
Placoderm
LATE DEVONIAN
DURATION: <3 my
MARINE GENERA OBSERVED EXTINGUISHED: 57%
CALCULATED MARINE SPECIES EXTINCT: 83%
SUSPECTED CAUSES: Impact, global cooling, loss of oxygen in oceans
END PERMIAN
DURATION: Unknown
MARINE GENERA OBSERVED EXTINGUISHED: 82%
CALCULATED MARINE SPECIES EXTINCT: 95%
SUSPECTED CAUSES: Dramatic fluctuations in climate or sea level; asteroid or comet impacts; severe volcanic activity
Rugose coral
Phytosaur teeth
END TRIASSIC
DURATION: 3 to 4 my
MARINE GENERA OBSERVED EXTINGUISHED: 53%
CALCULATED MARINE SPECIES EXTINCT: 80%
SUSPECTED CAUSES: Severe volcanism; global warming
END CRETACEOUS
DURATION: <1 my
MARINE GENERA OBSERVED EXTINGUISHED: 47%
CALCULATED MARINE SPECIES EXTINCT: 76%
SUSPECTED CAUSES: Impact; severe volcanism
Mosasaur
Millions of years ago
570
510
439
409
363
290
248
210
146
65
1.64
Cambrian
Ordovician
Silurian
Devonian
Carboniferous
Permian
Triassic
Jurassic
Cretaceous
Tertiary
Quaternary

H. Origin of Life on Earth?

- Biological Theory
  - Earth had many inorganic molecules that slowly changed to organic forms due to available energy and low oxygen (oxygen was TOXIC then!)
  - Became building blocks for complex molecules (amino acids, nucleotides, fats, sugars)
  - Led to forming polymers with the ability to replicate, store and transmit information (RNA first?)
  - Able to occur in solution or solid reactive surfaces

H. Origin of Life on Earth?

- Exact date of life's first appearance unknown
- Earth formed about 4.6 bya (billion years ago)
- Too hostile for life until 3.9 bya
- Earliest fossils 3.5 bya
- Likely between that window of time

I. Evidence of Common Ancestral Origin on Earth

- Common building blocks of life

  Such as?

- Universal genetic code